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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the optical tilt sensor for detecting directions, such as an electronic device, an angle, etc. easily.

[0002]

[Description of the Prior Art] In recent years, the tilt sensor is used for detection of inclination of consumer electronics, such as a digital camera and a digital camcorder. With respect to the tilt sensor in which the former of drawing 6 - drawing 8 is common, drawing 6 is a perspective view of a tilt sensor. Drawing 7 is an explanatory view showing the composition of the conventional common photo interrupter. Drawing 8 is an explanatory view showing the detection position of the tilt sensor which put the metal ball in the housing by which molding was carried out. Each figure explains the outline.

[0003] By drawing 6's putting the metal ball 1 in the mold body 4 which carried out molding to the gap G between the light receiving and emitting elements of the existing photo interrupter 10 which comprised a light emitting device and a photo detector, and the aforementioned metal ball 1 moving, and changing a position, With the signal from a 2-phase output, it has composition which detects three directions, an angle, etc.

[0004] In drawing 7, the photo interrupter 10 allocates the light emitting device 3 (for example, infrared LED) and the photo detector 2 (for example, photo-transistor P-Tr) in the portion which a case counters, and it is constituted so that the photo detector 2 may receive the light from the light emitting device 3 via the gap G. If a detected material enters in the gap G by the above-mentioned composition and light is intercepted, the output by the side of the photo detector 2 will change, and this output change will be used as a switching signal.

[0005] In drawing 8, the ball storage part of the housing by which molding was carried out [aforementioned] forms plane shape in approximately triangular shape, builds the one metal ball 1 into the aforementioned ball storage part, and forms the two sensor windows 7a and 7b in the euphotic side of the mold body 4a. The metal ball 1 rolls to arrow down, and both the sensor windows 7a and 7b of drawing 7 (a) will be in a euphotic state. The metal ball 1 rolls leftward [arrow], the sensor window 7a will be in a shaded state, and the sensor window 7b of drawing 7 (b) will be in a euphotic state. The metal ball 1 rolls rightward [arrow], the sensor window 7a will be in a euphotic state, and the sensor window 7b of drawing 7 (c) will be in a shaded state. Therefore, the angle of the three directions of a right-and-left 2-way and down is detectable by that of one tilt sensor.

[0006]

[Problem to be solved by the invention] However, the following problems are among the tilt sensors mentioned above. That is, although a 2-way or three directions are detectable with one tilt sensor,

when detecting four directions, three photo detectors must be built into a product. When detecting the direction of  $n$ , the photo detector of an individual ( $n-1$ ) must be incorporated. Therefore, it saw from the field of the both sides of cost and size, and became a problem.

[0007] This invention is made in view of the above-mentioned conventional problem, and is a thing. The purpose is to provide a tilt sensor which a package can be made smaller and can also reduce cost by minimum-izing the number of euphotic devices.

[0008]

[Means for solving problem] To achieve the above objects, the tilt sensor in this invention, A metal ball is made to be placed between the aforementioned gaps between the light receiving and emitting elements of the photo interrupter which a photo detector receives the light from a light emitting device via a gap, and detects the existence of a detected material by no contact. In the tilt sensor which detects a direction, an angle, etc. with the signal from two or more outputs by the position of this ball, The ball storage part of the housing which allocates photo detector plurality and stores two or more metal balls to the one aforementioned light emitting device performs detection of four or more directions on the same flat surface by using polygonal shape.

[0009] The ball storage part of the housing which stores the aforementioned metal ball forms plane shape in  $n$  square shape ( $n = 4$  or more even number). By making the number of metal balls into  $n/2$  piece, forming the sensor window of the aforementioned number of metal balls, and the same number in the acceptance surface side of a housing, and arranging so that a device may be united with a sensor window, The metal ball moved by inclination of a tilt sensor, the metal ball shaded the sensor window, and detection of the direction of  $n$  on the same flat surface was enabled with one tilt sensor.  $n$  square shape in this invention says the number of the substantial neighborhoods on which a metal ball acts, and a chamfering of the corner in the range without the influence on a metal ball is not included.

[0010] The ball storage part of the mold body which stores the aforementioned metal ball forms plane shape in  $n$  square shape ( $n = 5$  or more odd number). By making the number of metal balls into  $(n-1) / 2$  piece, forming  $(n+1) / 2$  sensor windows in the acceptance surface side of a housing, and arranging so that a euphotic device may be united with a sensor window, The metal ball moved by inclination of a tilt sensor, the metal ball shaded the sensor window, and detection of the direction of  $n$  on the same flat surface was enabled with one tilt sensor.

[0011] The ball storage part of the aforementioned housing forms plane shape approximately quadrangular shape or in the shape of an approximately hexagon. By building two pieces or three metal balls into the aforementioned ball storage part, forming two pieces or three sensor windows in the euphotic side of a housing, and arranging so that a euphotic device may be united with a sensor window, Two pieces or three metal balls moved by inclination of a tilt sensor, the metal ball shaded the sensor window, and detection of the four directions of [ on the same flat surface ] or six directions was enabled with one tilt sensor.

[0012] The housing which stores the aforementioned metal ball carried out molding of the plastic resin.

[0013] The lobe which tends toward a center was formed in the center section of at least one side of the inner circumference neighborhood of the ball storage part of the mold body which stores the aforementioned metal ball.

[0014]

[Mode for carrying out the invention] Based on Drawings, the tilt sensor in this invention is explained below. [Drawing 1](#), [drawing 2](#), and [drawing 3](#) are a 1st embodiment of this invention, and [drawing 1](#) is a perspective view showing the appearance of a tilt sensor. [Drawing 2](#) is a sectional view showing the internal structure of [drawing 1](#). [Drawing 3](#) is an explanatory view showing euphotic and a shaded state in the A-A line section of [drawing 2](#) according to the sensor window in a mold body,

and the physical relationship of a metal ball. In a figure, identical codes show the same component as conventional technology.

[0015]the two substrate 5 top with which the composition of a tilt sensor consists of glass epoxy resin etc. in [drawing 1](#) and [drawing 2](#) -- respectively -- the light emitting device 3 (LED) -- one piece and the photo detector 2 (P-Tr) -- a two-piece die bonded -- and -- wire bond mounting is carried out -- the sealing resin 6 -- a resin seal -- now, it is. Between the aforementioned carrier and the light emitting device, the housing which had the metal ball 1 stored is constituted by the two mold bodies 4a and 4b. Alignment is carried out and the two aforementioned mold bodies 4a and 4b are joined so that the sensor window 7 (slit) and the light-emitting window 8 (slit) may counter and it may become a position. A-A is the plane of composition. As for the ball storage part of the mold body which stores the metal ball 1, plane shape is formed in polygonal shape, such as approximately quadrangular shape.

[0016]As for [drawing 3](#), the two sensor windows 7a and 7b are formed for plane shape with approximately quadrangular shape, and, as for the ball storage part of a mold body, the two metal balls 1 are stored. [Drawing 3](#) (a), (b), (c), and (d) show the physical relationship of the two metal balls 1 at the time of rotating an arrow direction by a unit of 90 degrees, and the two sensor windows 7a and 7b. The sensor windows 7a and 7b of both [drawing 3](#) (a) are in a euphotic state. The sensor windows 7a are [ a euphotic state and the sensor window 7b of [drawing 3](#) (b) ] shaded states. The sensor windows 7a and 7b of both [drawing 3](#) (c) are shaded states. In the sensor window 7a, a shaded state and the sensor window 7b of [drawing 3](#) (d) are in a euphotic state. Namely, by the ball storage part of the housing which stores a metal ball forming plane shape in an approximately quadrangle, and making the number of metal balls into two pieces, and forming two sensor windows, the aforementioned number of metal balls, and the same number, in the acceptance surface side of a mold body, A metal ball moves by inclination of a tilt sensor, and the metal ball shades a sensor window and enables detection of four directions with one tilt sensor.

[0017][Drawing 4](#) is a 2nd embodiment of this invention, and is an explanatory view showing the physical relationship of a sensor window and a metal ball. As shown in [drawing 4](#), in the ball storage part of the mold body, the three sensor windows 7a, 7b, and 7c are formed for plane shape by the shape of an approximately hexagon, and the three metal balls 1 are stored. The sensor windows 7a, 7b, and 7c of both [drawing 4](#) (a) are in a euphotic state in the case where [drawing 4](#) (a), (b), (c), (d), (e), and (f) rotate an arrow direction by a unit of 60 degrees. The sensor windows 7a and 7b are [ a euphotic state and the sensor window 7c of [drawing 4](#) (b) ] shaded states. The sensor windows 7a are [ a euphotic state and the sensor windows 7b and 7c of [drawing 4](#) (c) ] shaded states. The sensor windows 7a, 7b, and 7c of both [drawing 4](#) (d) are shaded states. A shaded state and the sensor window 7c of [drawing 4](#) (e) of sensor window 7a7b are in a euphotic state. A shaded state and the sensor windows 7b and 7c of [drawing 4](#) (f) of 7a are in a euphotic state. Namely, by the ball storage part of the housing which stores a metal ball forming plane shape in an approximately hexagon, and making the number of metal balls into three pieces, and forming three sensor windows of the aforementioned number of metal balls, and the same number in the acceptance surface side of a mold body, A metal ball moves by inclination of a tilt sensor, and the metal ball shades a sensor window and enables detection of six directions with one tilt sensor.

[0019]As two embodiments mentioned above explained, the ball storage part of the mold body which stores the aforementioned metal ball forms plane shape in n square shape (n= 4 or more even number). By making the number of metal balls into n/2 piece, and forming the sensor window of the aforementioned number of metal balls, and the same number, i.e., n/2 piece, in the acceptance surface side of a mold body, A metal ball moves by inclination of a tilt sensor, and the metal ball shades a sensor window and enables detection of the direction of n with one tilt sensor.

[0020][Drawing 5](#) is a 3rd embodiment of this invention, and is an explanatory view showing the inner circumference form of the ball storage part of the mold body which carried out approximately

quadrangular shape. In drawing 5, the lobe 4c of approximately triangular shape is formed in the approximately center part of the neighborhood of the inner circumference of the ball storage part of the mold body 4a. As mentioned above, the two metal balls 1 move by inclination of a tilt sensor, but after the metal ball 1 moves, the metal ball 1 falls to the both sides of this lobe 4c, lessons is taken from them, and it has the function to stabilize the position of the metal ball 1.

[0021]

[Effect of the Invention]As explained above, since coplanar (two dimensions) detection of four or more directions can be performed with one tilt sensor according to this invention, reduction of parts cost and an assembly cost, a space saving, and a weight saving are attained, and a tilt sensor possible [ advanced features of a product and a miniaturization and slimming down ] and inexpensive can be provided.

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[Translation done.]